



DLA-97-P70146

# **DECISION SUPPORT TOOLS FOR THE ASSESSMENT OF COMMODITY BID OFFERS MADE TO THE DEFENSE NATIONAL STOCKPILE CENTER**

SEPTEMBER 1997

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**DECISION SUPPORT TOOLS FOR THE  
ASSESSMENT OF COMMODITY BID  
OFFERS MADE TO THE DEFENSE  
NATIONAL STOCKPILE CENTER**

**SEPTEMBER 1997**

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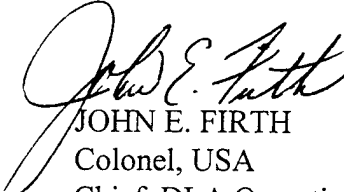
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**FOREWORD**

This report documents a study of commodity bid offers made to the Defense National Stockpile Center (DNSC). The purpose of the study was to provide DNSC with better information about potential changes in market commodity prices. This report provides the project findings of the new PC based price forecasting model, "market basket" decision support package, and "optimal" price methodology.

We would like to thank Mr. Peter Roman of DNSC-R for his overall guidance and assistance with this project. Additionally, we would like to thank Mr. Tom Rasmussen, Mr. Frank Ringquist, and Mr. Peter Mory for their insights into the commodity markets and guidance during the course of this project. This project would not have been possible without their assistance.

  
JOHN E. FIRTH  
Colonel, USA  
Chief, DLA Operations Research Office

## EXECUTIVE SUMMARY

The purpose of this study was to provide additional information to the management of the Defense National Stockpile Center (DNSC) about potential changes in commodity market prices. This report addresses the findings of a commodity market basket analysis, a "optimal" price methodology, and a PC based decision support system.

The market basket analysis of the commodities managed by the DNSC revealed that mathematical correlation exists between many of the commodities. However, the results of the study were inconclusive. This is because of the fact that correlation does not necessarily imply causality. A large positive or negative correlation coefficient does not mean that a change in commodity A automatically causes a change in commodity B. The only conclusion that may be inferred from the correlation coefficient is that a linear trend may exist between commodity A and commodity B.

The "optimal" price analysis focused on Aluminum Oxide Fused Crude. There was insufficient data to calculate the necessary production function for this technique to work. The available data cover a broad time span and does not offer many data points.

While it is disappointing that an "optimal pricing" strategy or a market basket could not be successfully developed, this does not necessarily symbolize a failure. It can be viewed instead as an illustration of the difficulty to provide reliable information of this type. This analysis may be feasible in the future if more data becomes available.

Lastly, the project team was successful in designing an automated PC based price forecasting model designed for use with Microsoft Excel ®. It is intended to complement the existing DNSC-R staff analysis of commodity markets. The program evaluates three different forecasts, Naïve forecast, Double exponential smoothing using Holt's method, and a Variable index dynamic average. It then chooses the forecast with the lowest overall error. Additionally, the program calculates a market momentum over a user specified number of periods and then graphs the output.

There exists significant potential benefits in applying this automated bid evaluation system to leverage increased revenue. Previous analysis of Lead sales for FY 97 demonstrated that this technique could have resulted in a net revenue increase of \$1.1 million dollars to the government. This represents a potential 15.8% increase in sales revenue for the period.

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## **SECTION 1**

### **STUDY DESCRIPTION**

#### **1.1 PROBLEM STATEMENT**

Develop a decision support system that will assist the Defense National Stockpile Center (DNSC) in assessing the suitability of bids on the commodities offered for public sale.

#### **1.2 BACKGROUND**

On November 19, 1996 at a meeting between DNSC and DLA Operations Research Office (DORO) management, the topic of decision support methodologies to assess the bids received for DNSC commodities was discussed. The DNSC management described the current methodology of assessing bids and wanted a more automated approach for bid evaluation that included alternate forecasting methodologies. The requirement is for a decision support package that will complement the research of the DNSC Marketing office and assist the DNSC decision makers in deciding which bids to award.

#### **1.3 OBJECTIVES**

**1.3.1** Develop a PC based price forecasting model which will provide an indication of what DNSC commodity prices might be in future international commodity markets.

**1.3.2** Research the potential for developing a "market basket" decision support package which will include all of the commodities sold by the DNSC.

**1.3.3** Explore potential methodologies for estimating the "optimal" price for various commodities.

#### **1.4 SCOPE**

Overall project functional guidance for this effort was provided by the DNSC Office of Planning & Market Research (DNSC-R), HQ DLA. All operational analysis support was accomplished by the technical support staff assigned by DORO in Richmond, Virginia.

## 1.5

### ASSUMPTIONS

There are several underlying assumptions associated with this study. The overall assumptions were: that any computer product that was developed must be uncomplicated for the user, based upon solid analysis and, provide useful information to the user. Additionally, it was assumed that the DNSC-R staff has limited time and resources for collecting additional data and prefers to employ data that is currently available. Specific assumptions are addressed where appropriate.

## 1.6

### LITERATURE OVERVIEW

After conducting a review of the forecasting literature it was determined that simple forecasting techniques can often be as effective as complex ones (Winston, 1994), (Nahmias, 1993), (Mahmoud, 1984), (Makridakis et al., 1982). It was not the intent of this study to evaluate every available forecasting technique, but rather to focus on several basic techniques which could yield better information about commodity prices. Thus, research on forecasting techniques for use in this study has focused on both traditional and non-traditional forecasting techniques that met this criteria.

## SECTION 2 STUDY APPROACH

### 2.1 ANALYTICAL TECHNIQUE

This project is a follow up effort to the consultation work DORO completed in February 1997. The earlier consultation focused on accurately forecasting the market direction for lead prices. This project addressed forecasting the expected market direction for the other commodities that DNSC manages.

An assumption used in this study is that some forecasting methods are better than others, depending upon the characteristics of the time series used for the evaluation (Armstrong, 1984). The forecasting techniques used in this project are considered to be time-series models. This means that each forecast is based upon past data.

It is important to review some fundamental characteristics inherent to predicting future values based on past observations. Forecasting problems are generally classified into three time horizons: short term, intermediate term, and long term. Short term business forecasts are typically measured in days or weeks. Examples of short term forecasts could be predicting daily sales or the number of employees required for shift scheduling. Intermediate term business forecasts are measured in weeks or months and represent the typical planning horizon for DNSC commodity forecasting. Long term business forecasts are usually measured in terms of years and often deal with issues such as long term sales patterns or capacity requirements.

While it is generally acknowledged by management and academia alike that forecasts are usually wrong, it is a fact that managers frequently disregard. The reasons for forecast inaccuracy are as varied as the number of forecasting techniques. This project has attempted to minimize forecast error by comparing multiple forecasting techniques and their associated error. It is assumed that any *viable* forecast must have a mean square error (MSE) or mean absolute deviation (MAD) that is less than the naïve forecast for the period. A naïve forecast is one in which the next period's demand is the same as the current period. The naïve forecast is as follows:

$$F_{t+1} = A_t$$

where:  $A_t$  = actual demand at time  $t$

$F_t$  = forecast for time  $t$



In plain language Naïve forecast looks like this:

$$\text{Forecast price} = \text{Last period price}$$

MAD can be described as the “absolute” sum of the total error divided by the total number of periods. The term absolute refers to changing all of the errors between the forecast and the actual prices into positive values. MSE is similar to MAD except that all of the error values are squared instead of changed into positive values. A characteristic desirable in all forecasts is that they should be unbiased, meaning that the error for each forecast should fluctuate randomly around zero. This can be measured using MAD and MSE with the goal of zero for both values. MAD and MSE are defined as:

$$\text{MAD} = \frac{\sum_{t=1}^n \text{ABS}(A_t - F_t)}{n}$$

$$\text{MSE} = \frac{\sum_{t=1}^n (A_t - F_t)^2}{n}$$

where:  $A_t$  = actual demand at time  $t$

$F_t$  = forecast for time  $t$

$n$  = number of periods

The forecasts used in this study were developed in the previous consultation. The techniques used for this study were: Naïve forecast, double exponential smoothing (DES) using Holt’s method, variable length dynamic index (VIDYA), and Chande momentum oscillator (CMO).

Double exponential smoothing using Holt’s method, is a technique that allows for the simultaneous smoothing of the data series and the trend. This method is designed to track time series data with a linear trend. DES requires the specification of two smoothing factors,  $(\alpha, \beta)$  and uses two equations. One equation is used to estimate the price and one to estimate the trend. A unique feature of this method is that it estimates a new slope for

the trend in the data with every new forecast. This method can be used for both single period and multiple period forecasts. DES is defined as:

$$S_t = \alpha D_t + (1 - \alpha)(S_{t-1} + G_{t-1}),$$

$$G_t = \beta(S_t - S_{t-1}) + (1 - \beta)G_{t-1}$$

$$F_t = S_t + G_t$$

where:  $S_t$  = value of the intercept at time  $t$

$D_t$  = most current price at time  $t$

$G_t$  = value of the slope at time  $t$

$F_t$  = forecast for time  $t$

$\alpha$  = smoothing constant for the data series

$\beta$  = smoothing constant for the trend

$\alpha \geq \beta$  = for stable forecasts

In plain language terms DSE looks like this:

$$\text{New Price} = \text{Smoothing Factor}_A * (\text{Current Price}) + (1 - \text{Smoothing Factor}_A) * (\text{Last Price} + \text{Last Slope}),$$

$$\text{New Slope} = \text{Smoothing Factor}_B * (\text{New Price} - \text{Last Price}) + (1 - \text{Smoothing Factor}_B) * (\text{Last Slope})$$

$$\text{New Forecast} = \text{New Price} + \text{New Slope}$$

The smoothing factor,  $(\alpha, \beta)$ , must be greater than or equal to zero or less than or equal to one for this model to work. The smoothing constant determines the relative weight placed on the current price in determining what the forecasted value must be. The smoothing constant can either be set at an arbitrary value chosen by the user or sometimes an optimal value can be determined. However, as the smoothing factor value increases the relative weight on each current observation increases thus producing a forecast which reacts quickly to changes but has greater variation from period to period.

In this study, regression analysis is used to estimate the initial values for the slope and intercept of the DES equations. Regression analysis is a method that fits a straight line to

a set of data. This technique enables the user to fit a line to the data that will minimize the distance of the initial data points from the line.

The third forecasting technique used in this study is called variable index dynamic average (VIDYA). This technique is a dynamic exponential moving average that adjusts its effective length using market variables and is responsive to market volatility. VIDYA can be indexed to the standard deviation of closing prices, a momentum oscillator, and to the coefficient of determination,  $r^2$ . The responsiveness and dynamic range of VIDYA will change based on the indexing technique used (Chande & Kroll, 1994). In this study, the standard deviation of closing prices was determined to be the most responsive. To use VIDYA, a volatility index must first be developed. The volatility index is derived from current volatility compared to historical volatility. This is represented as:

$$k = \sigma(x\text{-periods}) / \sigma(\text{reference})$$

where:  $k$  = volatility index

$\sigma(x\text{-periods})$  = standard deviation of prices over  $x$ -periods

$\sigma(\text{reference})$  = the historical value of standard deviation over  $x$ -periods

In plain language the volatility index is:

$$\text{Index } k = \text{standard deviation}(x\text{-periods}) / \text{standard deviation}(\text{reference})$$

The number of periods is chosen by the user. For example, you could use a 12 month moving average of standard deviation for the reference value. This would then become the historical reference value of standard deviation.

With the volatility index solved the VIDYA equation is expressed as:

$$\text{VIDYA} = \alpha * k * A_t + (1 - \alpha * k) * A_{t-1}$$

where:  $A_t$  = actual demand at time  $t$

$k$  = volatility index

$\alpha$  = smoothing constant for the data series

In plain language VIDYA looks like this:

$$\text{VIDYA} = \alpha * k * \text{Today's closing price} + (1 - \alpha * k) * \text{Yesterday's closing price}$$

The utility of this equation in forecasting prices is found in the addition of the indexing variable. This is substantially different than traditional exponential moving averages which require the index to be constant (Chande & Kroll, 1994).

To augment the forecasting strategies we incorporated methodologies designed to estimate market direction and momentum. The Chande momentum oscillator is a pure momentum oscillator that plots market momentum on a bounded scale of -100 to +100. The market momentum is measured as the difference between the closing prices of different periods. CMO is a variant of the Relative Strength Index (RSI) but differs from it in the following ways. CMO is a direct measurement of market momentum because it uses data for both up and down periods in its numerator. RSI calculations use only the data for up-periods in its market estimates. RSI has a built in smoothing feature which can effect the outcome of calculations. CMO works with unsmoothed data. Once calculated, the values can be smoothed just like any other market indicator. CMO calculations are bound by a -100 to +100 scale which enables the user to quickly assess the magnitude of the market shift. RSI varies from 0 to +100, so the user must use the 50 level for assessing the level of market momentum (Chande & Kroll, 1994).

The CMO is calculated using the sum of the up-period momentum over x periods represented as  $S_U$  and  $S_D$  is the sum of the down-period momentum over x periods. The CMO numerator is the difference between the sum of the up-period momentum and the sum of the down-period momentum multiplied by 100. The denominator is the absolute sum of the up-period momentum added to the sum of the down-period momentum (Chande & Kroll, 1994). CMO can be represented as:

$$\text{CMO} = 100 * (\Sigma_U - \Sigma_D) / |(\Sigma_U + \Sigma_D)|$$

In plain language terms CMO looks like this:

$$\text{CMO} = 100 * (\text{Sum up periods} - \text{Sum down periods}) / \text{ABS}(\text{Sum up periods} + \text{Sum down periods})$$

The usefulness of this indicator is that it can be easily plotted on a bounded scale and provides a consistent measure for comparing market shifts. Another feature of CMO is that it provides both negative and positive values, RSI only has positive values. This feature offers a clearer indication of both the direction and strength of the market momentum.

## **SECTION 3**

### **RESULTS**

#### **3.1**

#### **EXCEL®ADD IN**

An add in for Microsoft Excel ® was developed to assist the DNSC-R staff with their analysis of commodity markets and to automate the forecasting process developed in the previous consultation. The add in is designed to evaluate a range of prices chosen by the user and then graph the results. Once the user calls the program from the tools menu, he/she will be prompted to highlight the range of commodity prices. The user will then choose the periods for the CMO and how many months of output to be graphed. With these selections made, the user will then click on "Calculate" and the program will evaluate the data. The program evaluates Naïve, DES, and VIDYA forecasts for the period chosen. It then chooses the forecast with the lowest error and graphs the results. If the Naïve forecast has the lowest error then the program alerts the user that it can not make a reliable forecast.

It is important to note the effect of the momentum oscillator on the evaluation process. The user can choose a value between 3 to 18 periods. The greater the number of periods chosen the more stable the CMO estimate will be. Chande, the technique inventor, recommends 12 periods in his review of the technique. Consequently, 12 periods were used during the developmental phase of the study and for the previous consultation. This seemed to produce stable forecasts with the CMO generally following the movement of the actual and forecasted prices (see section 3.1.4 CMO Comparison analysis). However, Chande does specify that the choice is ultimately left to the user to determine the "right" number of periods for use. The DNSC-R add in is designed to incorporate the CMO chosen by the user into all calculations. Thus, if the user chooses 3 periods, the program will evaluate 3 periods worth of standard deviation, 3 periods of up/down momentum etc.

#### **3.2**

#### **MARKET BASKET ANALYSIS**

The commodities used for the market basket analysis and their cash sale values were provided by DNSC-R staff. The data covered sales for the period January 1995 through June 1997. With this information we determined an average per unit price for each commodity by dividing the sale value by the quantity sold. This data was used as the input for a macro written to determine potential market baskets candidates. The criteria for inclusion in a market basket was to employ any pair set whose correlation coefficient is greater than or equal to .5 or less than or equal to -.5. We determined that a positive or negative correlation of .5 was an indication of commodities potentially moving together.

A high positive coefficient between two commodities indicates their prices tend to rise and fall at the same time, conversely, a highly negative coefficient indicates that their prices tend to rise and fall in opposite directions. However, correlation does not necessarily imply causality. A large positive or negative correlation coefficient does not mean that a change in commodity A causes a change in commodity B. The only conclusion that may be inferred from the correlation coefficient is that a linear trend *may* exist between commodity A and commodity B. The correlation output matrix is at Appendix A.

### **3.3 OPTIMAL PRICING ANALYSIS**

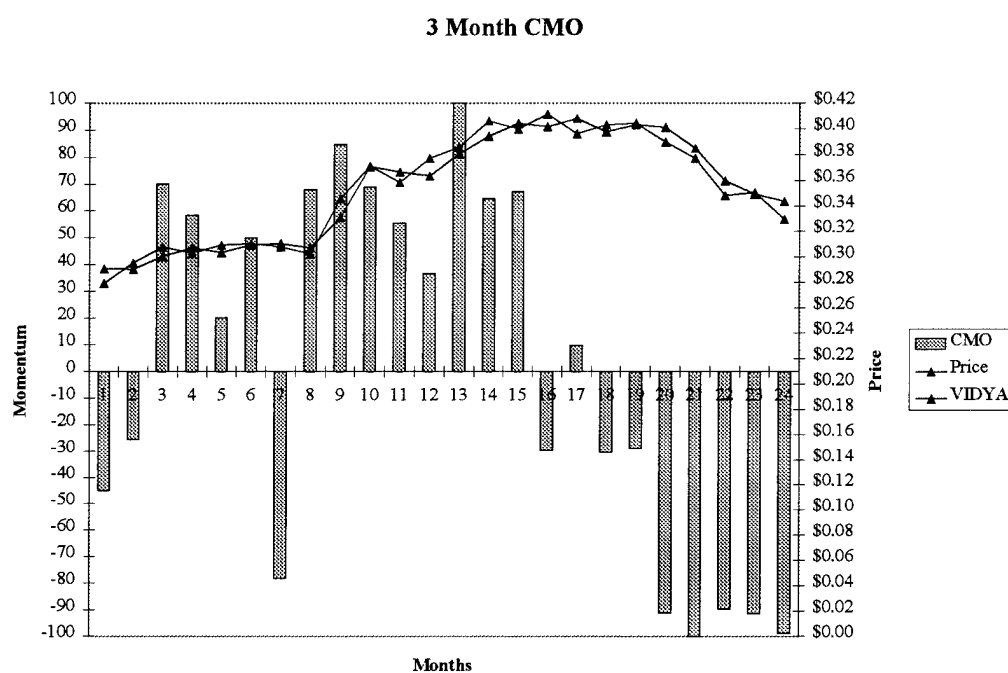
The optimal pricing analysis focused on Aluminum Oxide Fused Crude. To estimate a demand function for Aluminum Oxide Fused Crude, regression analysis was performed using the quantity sold and cash sale value (Ragsdale, 1995). The acquisition cost (a cumulative number) was estimated using 30 months worth of data provided by DNSC. The information necessary to estimate a production function (e.g., storage costs, labor costs, disposal costs) were unavailable. This made the estimation of an "optimal price" impossible.

The weakest link in both the "market basket" and the "optimal price" strategies is that the historical data that was provided spanned broad time intervals and does not offer many data points for use in forecasting. Consequently, the actual costs of the commodities at any point in time is difficult to estimate given the infrequent market activity for these commodities.

### **3.4 CMO COMPARISON ANALYSIS**

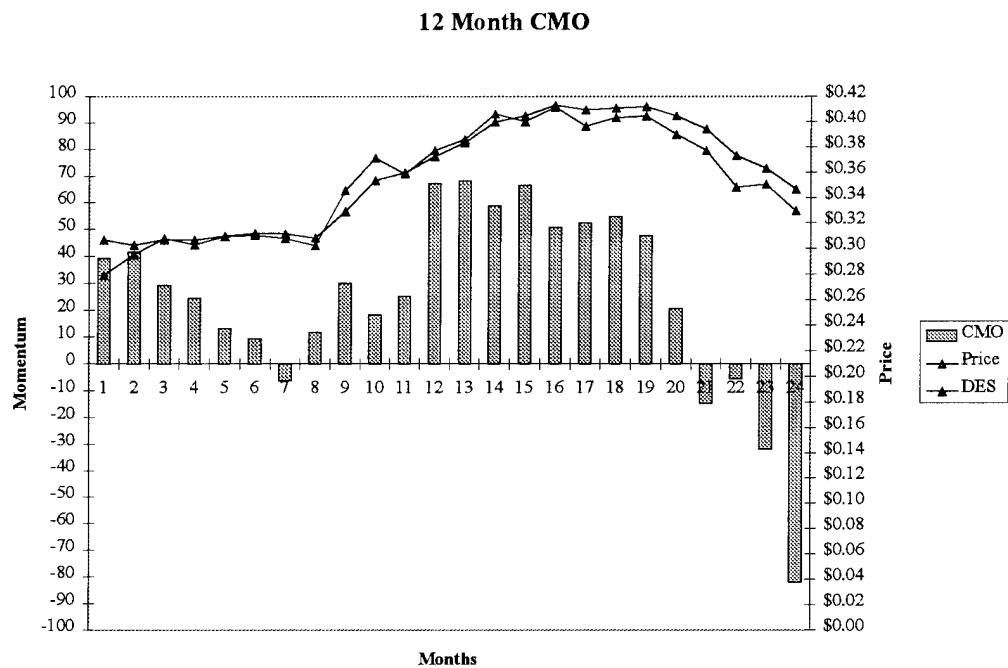
To illustrate the difference between choices in CMO refer to the following charts. All of the graphical output is from the same data set. It's obvious that there is considerable difference between the results. The 3 period CMO is very influenced by changes in the commodity price, while the 18 period CMO is less responsive to changes in prices. It is also interesting to note the differences in the error terms. Both DES and VIDYA have smaller errors than Naïve but are alternatively chosen (see individual error matrix). The technique developed during the previous consultation examining Lead prices was based on a 12 month CMO. The technique incorporated the direction of the CMO indicator, direction of the forecasted price and the direction of the actual price. If all displayed a downward trend then the recommendation was to sell down to the closing price. Which assumes the closing price next month would be even lower. If all were increasing or mixed then sell at the premium price. This assumes the closing price will be higher next month. It does not appear that this same technique will be as useful with other CMO

selections. Lastly, it is recommended that the user choose a 12 month CMO for evaluations of commodity prices.



\* The CMO will hit +/- 100 when there are 3 consecutive up or down price periods.

3 Month CMO	Error	ALPHA	BETA
VIDYA MSE	0.0001	0.4700	N/A
DES MSE	0.0002	0.5000	0.1500
Naive MSE	0.0005		
VIDYA MAD	0.0075	0.5000	N/A
DES MAD	0.0113	0.5000	0.0500
Naive MAD	0.0165		

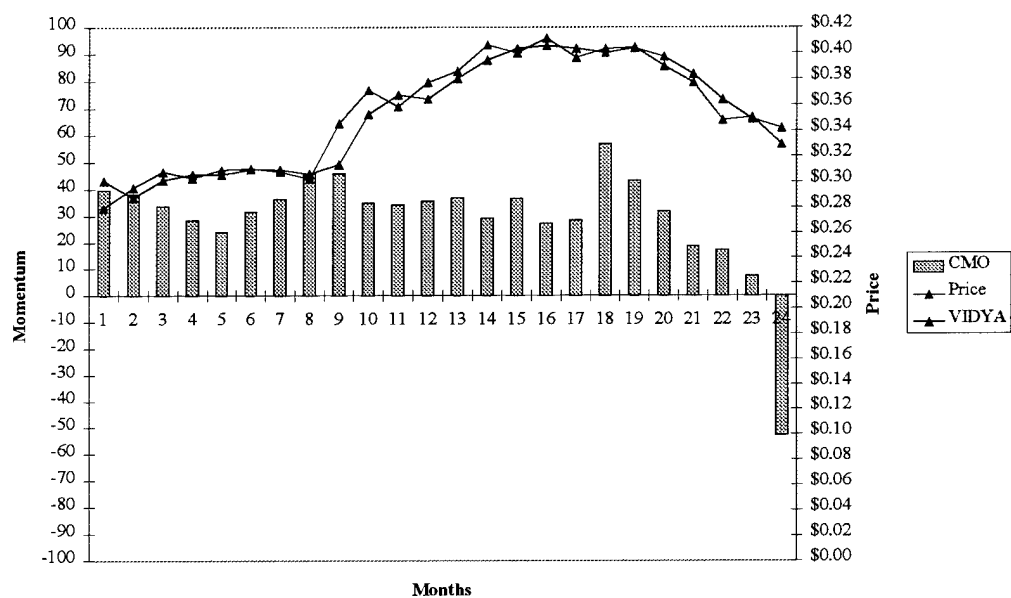


12 Month CMO	Error	ALPHA	BETA
DES MSE	0.0002	0.5000	0.0500
VIDYA MSE	0.0002	0.5000	N/A
Naïve MSE	0.0005		
VIDYA MAD	0.0098	0.5000	N/A
DES MAD	0.0099	0.5000	0.0500
Naïve MAD	0.0165		

\* DES MSE and VIDYA MSE are the same due to rounding to four decimals. DES MSE is actually .000172 vs. VIDYA MSE at .000175.



### 18 Month CMO



18 Month CMO	Error	ALPHA	BETA
VIDYA MSE	0.0001	0.5000	N/A
DES MSE	0.0002	0.5000	0.0500
Naïve MSE	0.0005		
VIDYA MAD	0.0083	0.5000	N/A
DES MAD	0.0101	0.5000	0.0500
Naïve MAD	0.0165		

## **SECTION 4 CONCLUSIONS**

The use of this automated bid evaluation system represents an opportunity for increased revenue. A previous analysis of Lead sales for FY 97 demonstrated that this technique could have resulted in a net revenue increase of \$1,051,722 dollars to the government. This represents a 15.8% increase in sales revenue for the period. These techniques may also be appropriate for the non-terminally traded commodities. Additional testing is required to substantiate the applicability to the non-terminally traded commodities.

Finally, it is disappointing that an "optimal pricing" strategy or a market basket could not be successfully developed with the techniques that were explored under this project. This does not necessarily represent a failure, but rather an illustration of the difficulty to provide reliable information about these infrequently traded commodities. Developing an "optimal pricing" strategy for this set of commodities may be possible in the future if additional historical data becomes available or by possibly exploring other analysis techniques associated with analysis of erratic and a periodic events.

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## Appendix A

The underlined commodities have a correlation coefficient .5 or greater (strong positive relationship) with the commodities listed below them.

### Aluminum

Bauxite Metal, Surinam	0.9995
Chromite, Chemical Grade	0.6446
Chromium Ferro High Carbon	0.8389
Columbium, Ferro	0.818
Germanium Metal	0.8269
Indium	0.8288
Kyanite	0.9995
Manganese Ferro High Carbon	0.8288
Manganese Ferro Silicon	0.9995
Mica Muscovite Block	0.5888
Mica Muscovite Film	0.5811
Palladium	0.8288
Platinum	0.9995
Quinidine	0.5069
Quinine	0.5521
Rubber	0.6661
Tantalum Carbide Powder	0.9995
Tantalum Oxide	0.9995
Vanadium	0.5151

### Aluminum Oxide Abrasive Grain

Columbium, Ferro	0.5972
Fluorspar Acid	0.64
Germanium Metal	0.5338
Indium	0.5337
Kyanite	0.5353
Manganese Electrolytic	0.5346
Manganese Ferro High Carbon	0.5337
Manganese Ferro Silicon	0.5353
Manganese Metal Ore	0.6887
Palladium	0.5337
Platinum	0.5353
Quindine	0.6708
Quinine	0.5794
Rubber	0.6599
Tantalum Carbide Powder	0.5353
Tantalum Oxide	0.5353

### Aluminum Oxide Fused Crude

Bauxite Metal, Surinam	0.5222
Columbium, Ferro	0.6324
Fluorspar Acid	0.6738
Germanium Metal	0.5752
Indium	0.5753
Kyanite	0.5916
Manganese Electrolytic	0.6276
Manganese Ferro High Carbon	0.5753
Manganese Ferro Silicon	0.5916
Mica Muscovite Block	0.925
Mica Muscovite Film	0.8542
Mica Muscovite Splittings	0.666
Palladium	0.5753
Platinum	0.5916
Quinidine	0.8392

### Antimony

Cadmium	0.5736
Cobalt	0.7302
Diamond Stone	0.5289
Iodine	0.7646
Nickel	0.573
Rutile	0.6469
Vegetable Tannin Quebracho	0.8399

### Bauxite Jamaican

Asbestos	0.6509
Beryllium	0.7331
Graphite Ceylon Malagasy	0.6164
Talc	0.9227

### Bauxite Refractory

Quinine	0.5231	Chromite Metal Ore	0.8087
Rubber	0.6733	Chromite Refractory	0.7623
Silicon Carbide	0.6261	Nickel	0.6544
Tantalum Carbide Powder	0.5916		
Tantalum Oxide	0.5916		
Vanadium	0.7102		
Vegetable Tannin Chestnut	0.5355		

### **Beryllium**

Columbium Ferro	0.6324
Germanium Metal	0.6447
Graphite Nat Malagasy	0.5289
Indium	0.6446
Kyanite	0.5916
Manganese Ferro High Carbon	0.6447
Manganese Ferro Silicon	0.5916
Palladium	0.6447
Platinum	0.5916
Rubber	0.7546
Talc	0.9273
Tantalum Carbide Powder	0.5916
Tantalum Oxide	0.5916

### **Bauxite, Surinam**

Beryllium	0.5222
Chromite Chemical	0.7098
Chromite Refractory	0.6302
Columbium Ferro	0.8184
Chromium Ferro High Carbon	1
Diamond Bort	0.9998
Germanium Metal	0.8239
Graphite Nat Malagasy	0.7779
Indium	0.8257
Kyanite	1
Manganese Electrolytic	0.5222
Manganese Ferro High Carbon	0.8257
Manganese Ferro Silicon	1
Mica Muscovite Block	0.6132
Mica Muscovite Film	0.6257
Mica Phlogopite Splittings	0.518
Palladium	0.8257
Platinum	1
Quindine	0.5285
Quinine	0.7006

### **Bismuth**

Chromite Metal Ore	0.5522
Chromite Refractory	0.5988
Cobalt	0.5563
Mica Phlogopite Splittings	0.6312
Silicon Carbide	0.6755
Zinc	0.6166

### **Cadmium**

Diamond Stone	0.5809
Iodine	0.8078
Manganese Chemical	0.7451
Manganese Dioxide Battery	0.6832
Rutile	0.7025

### **Chromite Chemical Grade**

Chromite Refractory	0.7233
Chromium Ferro High Carbon	0.5912
Columbium, Ferro	0.8622
Germanium Metal	0.8586
Indium	0.8585
Kyanite	0.7118
Manganese Ferro High Carbon	0.8585
Manganese Ferro Silicon	0.7118
Mica Muscovite Film	0.5002
Mica Phlogopite Splittings	0.7072
Palladium	0.8585
Platinum	0.7118
Quinine	0.5887
Rubber	0.6185
Tantalum Carbide Powder	0.7118
Tantalum Oxide	0.7118
Vegetable Tannin Wattle	0.5031

### **Chromite Chem Grade**

Chromium Refractory	0.7233
---------------------	--------

Rubber	0.6596	Chromium Ferro High Carbon	0.5912
Talc	1	Columbium, Ferro	0.8622
Tantalum Carbide Powder	1	Germanium Metal	0.8586
Tantalum Oxide	1	Indium	0.8585
Vegetable Tannin Wattle	0.6809	Kyanite	0.7118
		Manganese Ferro High Carbon	0.8585
		Manganese Ferro Silicon	0.7118
		Mica Muscovite Film	0.5002
		Palladium	0.8585
		Platinum	0.7118
		Quinine	0.5887
		Rubber	0.6185
<b><u>Chromite Ferro Silicon</u></b>		<b><u>Chromite Metal Ore</u></b>	
Graphite Nat Malagasy	0.699	Manganese Ferro Silicon	0.626
Chromium Refractory	0.7163	Mica Phlogopite Splittings	0.7051
Cobalt	0.6683	Platinum	0.626
Diamond Bort	0.5069	Sebacic Acid	0.5063
Manganese Metal Ore	0.5106	Tantalum Carbide Powder	0.626
Mica Phlogopite Splittings	0.5897	Tantalum Oxide	0.626
Nickel	0.6806		
Quartz	0.7208	<b><u>Columbium, Ferro</u></b>	
		Diamond Bort	0.8183
		Fluorspar Acid	0.588
		Germanium Metal	0.9995
<b><u>Chromium Ferro High Carbon</u></b>		Graphite Nat Malagasy	0.8907
Columbium, Ferro	0.8184	Indium	0.9999
Germanium Metal	0.8273	Kyanite	0.8141
Graphite Nat Malagasy	0.5204	Manganese Electrolytic	0.6324
Indium	0.8292	Manganese Ferro High Carbon	0.9999
Kyanite	1	Manganese Ferro Silicon	0.8141
Manganese Ferro High Carbon	0.8292	Mica Muscovite Block	0.6879
Manganese Ferro Silicon	1	Mica Muscovite Film	0.7543
Mica Muscovite Block	0.5214	Mica Phlogopite Splittings	0.5181
Mica Muscovite Film	0.5765	Palladium	0.9999
Palladium	0.8291	Platinum	0.8141
Platinum	1	Quinidine	0.64
Quinine	0.6355	Quinine	0.8485
Rubber	0.6672	Rubber	0.8294
Talc	0.6198	Tin	0.5245
Tantalum Carbide Powder	1	Talc	0.8184
Tantalum Oxide	1	Tantalum Carbide Powder	0.8141
Vanadium	0.5162	Tantalum Oxide	0.8141
		Vanadium	0.5813
<b><u>Cobalt</u></b>		Vegetable Tannin Wattle	0.8396
Mica Phlogopite Splittings	0.5829		

Nickel	0.5136
Vegetable Tannin Quebracho	0.7481

#### **Diamond Stone**

Iodine	0.6993
Manganese Chemical	0.7567
Manganese Dioxide Battery	0.6314
Rutile	0.7874
Sebacic Acid	0.7464
Vegetable Tannin Quebracho	0.5142

#### **Fluorspar Metal**

Manganese Chemical	0.5603
Manganese Dioxide Battery	0.6605
Mica Muscovite Film	0.5501
Mica Phlogopite Splittings	0.5329
Quinine	0.6659
Rubber	0.554
Sebacic Acid	0.6188
Vegetable Tannin Quebracho	0.6008

#### **Graphite Ceylon Malagasy**

Rutile	0.5641
Sebacic Acid	0.5249
Talc	0.5013

#### **Diamond Bort**

Germanium Metal	0.6842
Graphite Nat Malagasy	0.5447
Indium	0.829
Kyanite	0.9998
Manganese Electrolytic	0.5781
Manganese Electrolytic	0.5781
Manganese Ferro High Carbon	0.829
Manganese Ferro Silicon	0.9998
Palladium	0.829
Platinum	0.9998
Quartz	0.5281
Quinine	0.5142
Rubber	0.6666
Tantalum Carbide Powder	0.9998
Tantalum Oxide	0.9998
Vegetable Tannin Chestnut	0.5518
Vegetable Tannin Wattle	0.6343

#### **Germanium Metal**

Graphite Nat Malagasy	0.8941
Indium	0.9999
Kyanite	0.8197
Manganese Electrolytic	0.5641
Manganese Ferro High Carbon	0.9999
Manganese Ferro Silicon	0.8197
Mica Muscovite Block	0.6476
Mica Muscovite Film	0.7279

#### **Fluorspar Acid**

Germanium Metal	0.602
Indium	0.6019
Kyanite	0.5487
Manganese Electrolytic	0.6851
Manganese Ferro High Carbon	0.6019
Manganese Ferro Silicon	0.5487
Mica Muscovite Block	0.746
Mica Muscovite Film	0.7611
Palladium	0.6019
Platinum	0.5487
Quinidine	0.7858
Quinine	0.7111
Rubber	0.7278
Silicon Carbide	0.5471
Tantalum Carbide Powder	0.5487
Tantalum Oxide	0.5487
Vanadium	0.6135
Vegetable Tannin Chestnut	0.5222
Vegetable Tannin Wattle	0.5861

#### **Graphite Nat Malagasy**

Indium	0.8946
Kyanite	0.7732
Manganese Ferro High Carbon	0.8946
Manganese Ferro Silicon	0.7732
Palladium	0.8946
Platinum	0.7732

Mica Phlogopite Splittings	0.5096	Rubber	0.705
Palladium	0.9999	Sebacic Acid	0.5065
Platinum	0.8197	Talc	0.5349
Quinidine	0.5736	Tantalum Carbide Powder	0.7732
Quinine	0.8528	Tantalum Oxide	0.7732
Rubber	0.8339		
Talc	0.8273	<b><u>Iodine</u></b>	
Tantalum Carbide Powder	0.8197	Manganese Chemical	0.6317
Tantalum Oxide	0.8197	Manganese Dioxide Battery	0.5175
Tin	0.5043	Nickel	0.5554
Vanadium	0.5813	Rutile	0.9165
Vegetable Tannin Wattle	0.834	Vegetable Tannin Quebracho	0.5137

#### **Manganese Chemical**

Manganese Dioxide Battery	0.734
Rutile	0.7146

#### **Manganese Dioxide Battery**

Rutile	0.6279
Sebacic Acid	0.5925
Vanadium	0.5614

#### **Indium**

Kyanite	0.8216
Manganese Electrolytic	0.5641
Manganese Ferro High Carbon	1
Manganese Ferro Silicon	0.8216
Mica Muscovite Block	0.648
Mica Muscovite Film	0.7279
Mica Phlogopite Splittings	0.5104
Palladium	1
Platinum	0.8216
Quinidine	0.5736
Quinine	0.8528
Rubber	0.8338
Talc	0.8292
Tantalum Carbide Powder	0.8216
Tantalum Oxide	0.8216
Tin	0.5042
Vanadium	0.581
Vegetable Tannin Wattle	0.8439

#### **Manganese Electrolytic**

Manganese Ferro High Carbon	0.5641
Manganese Ferro Silicon	0.5916
Mica Muscovite Block	0.6205

#### **Kyanite**

Manganese Electrolytic	0.5916
Manganese Ferro High Carbon	0.8216
Manganese Ferro Silicon	1
Mica Muscovite Block	0.6525
Mica Muscovite Film	0.6488
Mica Phlogopite Splittings	0.6541
Palladium	0.8216
Platinum	1
Quinidine	0.5954
Quinine	0.6928
Rubber	0.6504
Talc	1
Tantalum Carbide Powder	1
Tantalum Oxide	1
Tin	0.5126
Vanadium	0.5291
Vegetable Tannin Wattle	0.6724

#### **Manganese Ferro High Carbon**

Manganese Ferro Silicon	0.8216
Mica Muscovite Block	0.648
Mica Muscovite Film	0.7279



Mica Muscovite Film	0.6591	Mica Phlogopite Splittings	0.5103
Mica Muscovite Splitting	0.5479	Palladium	1
Palladium	0.5641	Platinum	0.8216
Platinum	0.5916	Quindine	0.5736
Quindine	0.7982	Quinine	0.8528
Quinine	0.6299	Rubber	0.8338
Rubber	0.6602	Talc	0.8292
Silicon Carbide	0.743	Tantalum Carbide Powder	0.8216
Tantalum Carbide Powder	0.5916	Tantalum Oxide	0.8216
Tantalum Oxide	0.5916	Tin	0.5042
Vegetable Tannin Chestnut	0.7632	Vanadium	0.581
Vegetable Tannin Wattle	0.6786	Vegetable Tannin Wattle	0.8439
Zinc	0.5426		

#### **Manganese Metal Ore Grade**

Quartz	0.8041
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#### **Mica Muscovite Splittings**

Vegetable Tannin Chestnut	0.5991
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#### **Mica Phlogopite Splittings**

Palladium	0.5104
Platinum	0.6541
Tantalum Carbide Powder	0.6541
Tantalum Oxide	0.6541
Vegetable Tannin Quebracho	0.6866

#### **Nickel**

Rutile	0.5364
--------	--------

#### **Manganese Ferro Silicon**

Mica Muscovite Block	0.6525
Mica Muscovite Film	0.6488
Mica Phlogopite Splittings	0.6541
Palladium	0.8216
Platinum	1
Quinidine	0.5954
Quinine	0.6928
Rubber	0.6504
Talc	1
Tantalum Carbide Powder	1
Tantalum Oxide	1
Tin	0.5126
Vanadium	0.5291
Vegetable Tannin Wattle	0.6724

#### **Mica Muscovite Block**

Mica Muscovite Film	0.9296
Mica Muscovite Splittings	0.5137
Palladium	0.648
Platinum	0.6525
Quinidine	0.9113
Quinine	0.5869
Rubber	0.7179
Silicon Carbide	0.5677
Silver	0.5333
Tantalum Carbide Powder	0.6525
Tantalum Oxide	0.6525
Vanadium	0.8107
Vegetable Tannin Chestnut	0.5603

#### **Mica Muscovite Film**

Palladium	0.7279
Platinum	0.6488
Quinidine	0.8305

#### **Platinum**

Quinidine	0.5954
Quinine	0.6928
Rubber	0.6504
Talc	1

Quinine	0.7105	Tantalum Carbide Powder	1
Rubber	0.7624	Tantalum Oxide	1
Silicon Carbide	0.6208	Tin	0.5126
Silver	0.5729	Vanadium	0.5291
Tantalum Carbide Powder	0.6488	Vegetable Tannin Wattle	0.6724
Tantalum Oxide	0.6488		
Vanadium	0.8141	<b><u>Quinidine</u></b>	
Vegetable Tannin Chestnut	0.6125	Quinine	0.5318
Vegetable Tannin Wattle	0.5687	Rubber	0.6714
Zinc	0.5713	Silicon Carbide	0.5857
		Silver	0.7194
<b><u>Palladium</u></b>		Tantalum Carbide Powder	0.5954
Platinum	0.8216	Tantalum Oxide	0.5954
Quinidine	0.5736	Vanadium	0.8309
Quinine	0.8528	Vegetable Tannin Chestnut	0.6138
Rubber	0.8338		
Talc	0.8292	<b><u>Rutile</u></b>	
Tantalum Carbide Powder	0.8216	Sebacic Acid	0.5459
Tantalum Oxide	0.8216		
Tin	0.5042	<b><u>Silicon Carbide</u></b>	
Vanadium	0.581	Vegetable Tannin Chestnut	0.7044
Vegetable Tannin Wattle	0.8439	Vegetable Tannin Wattle	0.5023
		Zinc	0.771
<b><u>Quinine</u></b>			
Rubber	0.9982	<b><u>Silver</u></b>	
Tantalum Carbide Powder	0.6928	Vanadium	0.7058
Tantalum Oxide	0.6928		
Vegetable Tannin Chestnut	0.5056		
Vegetable Tannin Wattle	0.8724		
<b><u>Rubber</u></b>		<b><u>Talc</u></b>	
Silver	0.5332	Tantalum Carbide Powder	1
Talc	0.6672	Tantalum Oxide	1
Tantalum Carbide Powder	0.6504		
Tantalum Oxideq	0.6504	<b><u>Vegetable Tannin Chestnut</u></b>	
Tin	0.6891	Vegetable Tannin Wattle	0.6414
Vanadium	0.6801	Zinc	0.5497
Vegetable Tannin Chestnut	0.5		
Vegetable Tannin Wattle	0.9993		
<b><u>Tantalum Carbide Powder</u></b>			
Tantalum Oxide	1		
Tin	0.5126		
Vanadium	0.5291		
Vegetable Tannin Wattle	0.6724		

The underlined commodities have a correlation coefficient  $\geq .5$  or less (strong negative relationship) with the commodities listed below them.

<b><u>Antimony</u></b>		<b><u>Manganese Ferro Silicon</u></b>	
Aluminum Oxide Abrasive Grain	-0.801	Antimony	-0.563
<b><u>Cadmium</u></b>		Cadmium	-0.529
Aluminum Oxide Abrasive Grain	-0.847	Cobalt	-0.697
<b><u>Diamond Stones</u></b>		Iodine	-0.592
Aluminum Oxide Abrasive Grain	-0.707	<b><u>Manganese Metal Ore</u></b>	
<b><u>Germanium Metal</u></b>		Cadmium	-0.858
Cadmium	-0.528	Diamond Stones	-0.528
<b><u>Indium</u></b>		Iodine	-0.66
Cadmium	-0.528	Manganese Chemical	-0.746
<b><u>Iodine</u></b>		Manganese Dioxide Battery	-0.656
Aluminum Oxide Abrasive Grain	-0.979	<b><u>Mica Muscovite Splittings</u></b>	
Fluorspar Acid	-0.689	Manganese Ferro Silicon	-0.566
Germanium Metal	-0.564	Kyanite	-0.566
Indium	-0.564	<b><u>Nickel</u></b>	
<b><u>Kyanite</u></b>		Aluminum Oxide Fused Crude	-0.525
Antimony	-0.563	Kyanite	-0.521
Cadmium	-0.529	Lead	-0.532
Cobalt	-0.697	Manganese Ferro Silicon	-0.521
Iodine	-0.592	Mica Muscovite Block	-0.676
<b><u>Lead</u></b>		<b><u>Palladium</u></b>	
Bauxite Refractory	-0.605	Cadmium	-0.528
<b><u>Manganese Chemical</u></b>		Iodine	-0.564
Aluminum Oxide Abrasive Grain	-0.66	<b><u>Platinum</u></b>	
<b><u>Manganese Dioxide Battery</u></b>		Antimony	-0.563
Aluminum Oxide Abrasive Grain	-0.553	Cadmium	-0.529
<b><u>Manganese Electrolytic</u></b>		Cobalt	-0.697
Iodine	-0.607	Iodine	-0.592
		Mica Muscovite Splittings	-0.566
		Nickel	-0.521
		<b><u>Quartz</u></b>	
		Cadmium	-0.74
		Manganese Chemical	-0.616

		Manganese Dioxide Battery	-0.513
<b><u>Manganese Ferro High Carbon</u></b>			
Cadmium	-0.528	<b><u>Tantalum Oxide</u></b>	
Iodine	-0.564	Antimony	-0.563
		Cadmium	-0.529
<b><u>Quinine</u></b>		Cobalt	-0.697
Iodine	-0.568	Iodine	-0.592
		Mica Muscovite Splittings	-0.566
<b><u>Quinidine</u></b>		Nickel	-0.521
Antimony	-0.697	Rutile	-0.507
Chromite Metal Ore	-0.614		
Iodine	-0.713	<b><u>Vanadium</u></b>	
Nickel	-0.787	Chromite Metal Ore	-0.53
		Nickel	-0.715
<b><u>Rubber</u></b>			
Antimony	-0.534	<b><u>Vegetable Tannin Quebracho</u></b>	
Cadmium	-0.6	Aluminum Oxide Abrasive Grain	-0.571
Iodine	-0.66	Kyanite	-0.573
Nickel	-0.544	Manganese Ferro Silicon	-0.573
		Platinum	-0.573
<b><u>Rutile</u></b>		Tantalum Carbide Powder	-0.573
Aluminum Oxide Abrasive Grain	-0.89	Tantalum Oxide	-0.573
Fluorspar Acid	-0.612		
Kyanite	-0.507	<b><u>Tantalum Carbide Powder</u></b>	
Platinum	-0.507	Antimony	-0.563
Quinidine	-0.632	Cadmium	-0.529
Quinine	-0.51	Cobalt	-0.697
Manganese Ferro Silicon	-0.507	Iodine	-0.592
Manganese Metal Ore	-0.626	Mica Muscovite Splittings	-0.566
Rubber	-0.576	Nickel	-0.521
		Rutile	-0.507
<b><u>Sliver</u></b>			
Bauxite Refractory	-0.633		
Chromite Metal Ore	-0.676		
Nickel	-0.835		

## Appendix B

This appendix contains the Visual Basic code that runs the PC add in developed by DORO for DNSC. It is assumed the reader understands Visual Basic and that this inclusion will explain what is happening behind the screen. Each module performs a specified task and all tasks are listed in the sequence in which they run.

' This program is the result of numerous contributions from a  
' variety of people. I would like to Thank Major Mark Entner,  
' Ms. Maureen Kinkela, and Mr. Ben Roberts. Without their  
' help, suggestions, and patience this program would have  
' not been possible. Major Randy Zimmerman, August 1997.

Public Measure As Integer  
Public Months As Integer  
Public Momentum As Integer  
Public Price As Variant

' Button3\_Click Macro  
Sub Button3\_Click() 'closes the macro calculation dialog box  
    DialogSheets("Dialog1").Hide  
    End  
End Sub

Sub Analysis()  
    Start  
    ' ThisWorkbook.DialogSheets("Dialog1").Show  
    ' Price = ThisWorkbook.DialogSheets("Dialog1").EditBoxes("Edit Box 5").Text  
    ' Measure = ThisWorkbook.Worksheets("Sheet1").Cells(1, 2)  
    ' Months = ThisWorkbook.Worksheets("Sheet1").Cells(1, 4) \* 3  
    ' Momentum = ThisWorkbook.Worksheets("Sheet1").Cells(1, 6)  
    Range(Price).Select  
    Selection.Copy  
    ' Errorcheck (Price) 'checks the #months to graph vs #months input  
    CreateNewbook 'inserts a new workbook for the evaluation  
    Conversion (Price) 'converts the price values to \$/LB  
    Formatsheet 'formats the new sheet w/column headings  
    CountRow 'performs the count function for the number of rows read in  
    Equations (Price) 'inserts the equations on Evaluation sheet  
    Oscillation 'sets the momentum oscillation for the eval sheet  
    SOLVE\_DES\_MAD  
    SOLVE\_DES\_MSE

```

' SOLVE_VIDYA_MAD
SOLVE_VIDYA_MSE
Sort 'sorts the error terms in ascending order
SelectTest 'select rows in Eval Table to graph Select Graph
Selectspace 'selects cell A1 on all sheets
End Sub

Sub Start()
line1: ThisWorkbook.DialogSheets("Dialog1").Show
    Price = ThisWorkbook.DialogSheets("Dialog1").EditBoxes("Edit Box 5").Text
    Measure = ThisWorkbook.Worksheets("Sheet1").Cells(1, 2)
    Months = ThisWorkbook.Worksheets("Sheet1").Cells(1, 4) * 3
    Momentum = ThisWorkbook.Worksheets("Sheet1").Cells(1, 6)

'Sub Errorcheck(Price2)
    a = Range(Price).count
    If a < Months Then
        Msg = "You are attempting to graph too many months!"
        dialogstyle = vbOK + vbCritical
        Title = "Price Input Error"
        response = MsgBox(Msg, dialogstyle, Title)
        If response = vbOK Then
            GoTo line1
        End If
    End If

End Sub

Sub CreateNewbook()
    Set Newbook = Workbooks.Add 'adds new book "newbook is a variable"
    ActiveSheet.Name = "Evaluation Sheet"
    Range("A3").Select 'tells code what cell to highlight/Paste in prices
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
End Sub

Sub Conversion(Price1) 'converts prices to $/LB
    z = 3
    If Measure = 1 Then
    ElseIf Measure = 2 Then
        Do Until Cells(z, 1).Value = ""
            Cells(z, 1).Value = Cells(z, 1).Value * 2.20462262184878
            z = z + 1
        Loop
    End If
End Sub

```

```

ElseIf Measure = 3 Then
    Do Until Cells(z, 1).Value = ""
        Cells(z, 1).Value = Cells(z, 1).Value / 2240
        z = z + 1
    Loop
ElseIf Measure = 4 Then
    Do Until Cells(z, 1).Value = ""
        Cells(z, 1).Value = Cells(z, 1).Value / 2204.62262184878
        z = z + 1
    Loop
ElseIf Measure = 5 Then
    Do Until Cells(z, 1).Value = ""
        Cells(z, 1).Value = Cells(z, 1).Value / 2000
        z = z + 1
    Loop
ElseIf Measure = 6 Then
    Do Until Cells(z, 1).Value = ""
        Cells(z, 1).Value = Cells(z, 1).Value / 2000
        z = z + 1
    Loop
End If
End Sub

```

```

Sub Formatsheet()
    Range("A1").Select
    ActiveCell.FormulaR1C1 = "Price/LB"
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = xlHorizontal
    End With
    Range("A2").Select
    Selection.ClearContents
    Range("B1").Select
    ActiveCell.FormulaR1C1 = "DES Forecast"
    Range("C1").Select
    ActiveCell.FormulaR1C1 = "VIDYA Forecast"
    Range("D1").Select
    ActiveCell.FormulaR1C1 = "CMO Indicator"
    Range("E1").Select
    ActiveCell.FormulaR1C1 = "Naive Forecast"
    Range("F1").Select
    ActiveCell.FormulaR1C1 = "Naive MAD"
    Range("G1").Select

```

```

ActiveCell.FormulaR1C1 = "Naive MSE"
Range("H1").Select
ActiveCell.FormulaR1C1 = "DES Intercept"
Range("I1").Select
ActiveCell.FormulaR1C1 = "DES Slope"
Range("J1").Select
ActiveCell.FormulaR1C1 = "DES MAD"
Range("K1").Select
ActiveCell.FormulaR1C1 = "DES MSE"
Range("L1").Select
ActiveCell.FormulaR1C1 = "STD DEV"
Range("M1").Select
ActiveCell.FormulaR1C1 = "k"
With Selection
    .HorizontalAlignment = xlCenter
    .VerticalAlignment = xlBottom
    .WrapText = False
    .Orientation = xlHorizontal
End With
Range("N1").Select
ActiveCell.FormulaR1C1 = "VIDYA MAD"
Range("O1").Select
ActiveCell.FormulaR1C1 = "VIDYA MSE"
Range("P1").Select
ActiveCell.FormulaR1C1 = "CMO Mtm Up"
Range("Q1").Select
ActiveCell.FormulaR1C1 = "CMO Mtm Dn"
Range("R1").Select
ActiveCell.FormulaR1C1 = "Su"
With Selection
    .HorizontalAlignment = xlCenter
    .VerticalAlignment = xlBottom
    .WrapText = False
    .Orientation = xlHorizontal
End With
Range("S1").Select
ActiveCell.FormulaR1C1 = "Sd"
With Selection
    .HorizontalAlignment = xlCenter
    .VerticalAlignment = xlBottom
    .WrapText = False
    .Orientation = xlHorizontal
End With
Range("T1").Select
ActiveCell.FormulaR1C1 = "ABS CMO"

```



```

Range("U3").Select
ActiveCell.FormulaR1C1 = "a"
Range("U4").Select
ActiveCell.FormulaR1C1 = "b"
Range("U5").Select
ActiveCell.FormulaR1C1 = "Ave STD DEV"
Range("A1:AA1").Select
Selection.EntireColumn.AutoFit
Range("U3:U4").Select
With Selection.Font
    .Name = "Symbol"
    .FontStyle = "Regular"
    .Size = 12
    .Strikethrough = False
    .Superscript = False
    .Subscript = False
    .OutlineFont = False
    .Shadow = False
    .Underline = xlNone
    .ColorIndex = xlAutomatic
End With
End Sub

```

Sub autofill(startpt As String, formula As String)

```

Range(startpt).Select
ActiveCell.formula = formula
Range(startpt).Select
cnt% = ActiveSheet.Cells(6, 22).Value
autorange$ = startpt + ":" + Left$(startpt, 1) + _
    LTrim(Str$(Val(Mid$(startpt, 2)) + cnt% + 2 - Val(Mid$(startpt, 2))))
'MsgBox autorange$ + Str$(cnt%)
Selection.autofill Destination:=Range(autorange$), Type:=xlFillDefault
Range(autorange$).Select
End Sub

```

Sub CountRow()

```

Dim i As Integer
i = 3
count = 0
ActiveSheet.Cells(3, 1).Select
Do While Cells(i, 1) > 0
    count = count + 1
    i = i + 1
Loop

```

```
Worksheets("Evaluation Sheet").Cells(6, 22).Value = count
End Sub
```

```
Sub Equations(Price)
```

```
Dim Price2 As Range
```

```
Set Price2 = Range(Price).Offset(2, 0)
```

```
Range("V3").Select
```

```
ActiveCell.formula = "=.5" 'Start value for Alpha
```

```
Range("V4").Select
```

```
ActiveCell.formula = "=.5" 'Start value for Beta
```

```
Range("f2").Select
```

```
ActiveCell.formula = "=sum(average(f4:f1000))"
```

```
Range("g2").Select
```

```
ActiveCell.formula = "=sum(average(g4:g1000))"
```

```
Range("j2").Select
```

```
ActiveCell.formula = "=sum(average(j3:j1000))"
```

```
Range("k2").Select
```

```
ActiveCell.formula = "=sum(average(k3:k1000))"
```

```
Range("n2").Select
```

```
ActiveCell.formula = "=sum(average(n3:n1000))"
```

```
Range("o2").Select
```

```
ActiveCell.formula = "=sum(average(o3:o1000))"
```

```
Range("B3").Select
```

```
Call autofill("b3", "=H3+I3")
```

```
Call autofill("E4", "=A3") 'Naive forecast
```

```
Call autofill("F4", "=ABS(A4-E4)") 'Naive MAD
```

```
Call autofill("G4", "=ABS(F4)^2") 'Naive MSE
```

```
Call autofill("H3", "=$V$3*A3+(1-$V$3)*(H2+I2)") 'DES Intercept calculation
```

```
Call autofill("I3", "=$V$4*(H3-H2)+(1-$V$4)*I2") 'DES Slope calculation
```

```
Call autofill("J3", "=ABS(A3-B3)") 'DSE MAD
```

```
Call autofill("K3", "=(J3)^2") 'DES MSE
```

```
Call autofill("P3", "=IF(A3>A4,0,A4-A3)") 'CMO Mtm Up
```

```
Call autofill("Q3", "=IF(A3>A4,A3-A4,0)") 'CMO Mtm Down
```

```
Range("A2:Y1000").Select
```

```
With Selection
```

```
.HorizontalAlignment = xlCenter
```

```
.VerticalAlignment = xlBottom
```

```
.WrapText = False
```

```
.Orientation = xlHorizontal
```

```
End With
```

```
Selection.NumberFormat = "0.0000"
```

```
Selection.EntireColumn.AutoFit
```

```
End Sub
```

```
Sub Oscillation()
```

```

If Momentum = 1 Then
Range("C4").Select
ActiveCell.formula = "=A4"
Call autofill("C5", "=(\$V\$3*M5)*A5+(1-\$V\$3*M5)*A4") 'VIDYA forecast
Call autofill("D5", "=100*(R5-S5)/ABS(R5+S5)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$5),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$5),1)" 'slope of line
Call autofill("L5", "=STDEV(A3:A5)") '3MO STD DEV
Call autofill("M5", "=L5/\$V\$5") 'K value calculation
Call autofill("N5", "=ABS(A5-C5)") 'VIDYA MAD
Call autofill("O5", "=(N5)^2") 'VIDYA MSE
Call autofill("R5", "=SUM(P3:P5)") 'Su Mtm Up
Call autofill("S5", "=SUM(Q3:Q5)") 'Su Mtm Up
Call autofill("T5", "=ABS((R5-S5)/(R5+S5)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE(\$L\$5:\$L\$10)" 'VIDYA Constant of Ave Std Dev

```

```

ElseIf Momentum = 2 Then
Range("C5").Select
ActiveCell.formula = "=A5"
Call autofill("C6", "=(\$V\$3*M6)*A6+(1-\$V\$3*M6)*A5") 'VIDYA forecast
Call autofill("D6", "=100*(R6-S6)/ABS(R6+S6)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$6),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$6),1)" 'slope of line
Call autofill("L6", "=STDEV(A3:A6)") '4 MO STD DEV
Call autofill("M6", "=L6/\$V\$5") 'K value calculation
Call autofill("N6", "=ABS(A6-C6)") 'VIDYA MAD
Call autofill("O6", "=(N6)^2") 'VIDYA MSE
Call autofill("R6", "=SUM(P3:P6)") 'Su Mtm Up
Call autofill("S6", "=SUM(Q3:Q6)") 'Su Mtm Up
Call autofill("T6", "=ABS((R6-S6)/(R6+S6)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE(\$L\$6:\$L\$13)" 'VIDYA Constant of Ave Std Dev

```

```

ElseIf Momentum = 3 Then
Range("C6").Select
ActiveCell.formula = "=A6"
Call autofill("C7", "=(\$V\$3*M7)*A7+(1-\$V\$3*M7)*A6") 'VIDYA forecast
Call autofill("D7", "=100*(R7-S7)/ABS(R7+S7)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$7),2)" 'Y intercept

```

```

Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$7),1)" 'slope of line
Call autofill("L7", "=STDEV(A3:A7)" '5 MO STD DEV
Call autofill("M7", "=L7/$V$5)" 'K value calculation
Call autofill("N7", "=ABS(A7-C7)" 'VIDYA MAD
Call autofill("O7", "=(N7)^2)" 'VIDYA MSE
Call autofill("R7", "=SUM(P3:P7)" 'Su Mtm Up
Call autofill("S7", "=SUM(Q3:Q7)" 'Su Mtm Up
Call autofill("T7", "=ABS((R7-S7)/(R7+S7))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$7:$L$16)" 'VIDYA Constant of Ave Std Dev

```

ElseIf Momentum = 4 Then

```

Range("C7").Select
ActiveCell.formula = "=A7"
Call autofill("C8", "=( $V$3*M8)*A8+(1-$V$3*M8)*A7)" 'VIDYA forecast
Call autofill("D8", "=100*(R8-S8)/ABS(R8+S8)" 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$8),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$8),1)" 'slope of line
Call autofill("L8", "=STDEV(A3:A8)" '6 MO STD DEV
Call autofill("M8", "=L8/$V$5)" 'K value calculation
Call autofill("N8", "=ABS(A8-C8)" 'VIDYA MAD
Call autofill("O8", "=(N8)^2)" 'VIDYA MSE
Call autofill("R8", "=SUM(P3:P8)" 'Su Mtm Up
Call autofill("S8", "=SUM(Q3:Q8)" 'Su Mtm Up
Call autofill("T8", "=ABS((R8-S8)/(R8+S8))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$8:$L$19)" 'VIDYA Constant of Ave Std Dev

```

ElseIf Momentum = 5 Then

```

Range("C8").Select
ActiveCell.formula = "=A8"
Call autofill("C9", "=( $V$3*M9)*A9+(1-$V$3*M9)*A8)" 'VIDYA forecast
Call autofill("D9", "=100*(R9-S9)/ABS(R9+S9)" 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$9),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$9),1)" 'slope of line
Call autofill("L9", "=STDEV(A3:A9)" '7 MO STD DEV
Call autofill("M9", "=L9/$V$5)" 'K value calculation
Call autofill("N9", "=ABS(A9-C9)" 'VIDYA MAD
Call autofill("O9", "=(N9)^2)" 'VIDYA MSE
Call autofill("R9", "=SUM(P3:P9)" 'Su Mtm Up

```

```

Call autofill("S9", "=SUM(Q3:Q9)") 'Su Mtm Up
Call autofill("T9", "=ABS((R9-S9)/(R9+S9))") ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$9:$L$22)" 'VIDYA Constant of Ave Std Dev

ElseIf Momentum = 6 Then
Range("C9").Select
ActiveCell.formula = "=A9"
Call autofill("C10", "=( $V$3*M10)*A10+(1-$V$3*M10)*A9") 'VIDYA forecast
Call autofill("D10", "=100*(R10-S10)/ABS(R10+S10)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$10),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$10),1)" 'slope of line
Call autofill("L10", "=STDEV(A3:A10)") '8 MO STD DEV
Call autofill("M10", "=L10/$V$5") 'K value calculation
Call autofill("N10", "=ABS(A10-C10)") 'VIDYA MAD
Call autofill("O10", "= (N10)^2") 'VIDYA MSE
Call autofill("R10", "=SUM(P3:P10)") 'Su Mtm Up
Call autofill("S10", "=SUM(Q3:Q10)") 'Su Mtm Up
Call autofill("T10", "=ABS((R10-S10)/(R10+S10))") ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$10:$L$25)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 7 Then
Range("C10").Select
ActiveCell.formula = "=A10"
Call autofill("C11", "=( $V$3*M11)*A11+(1-$V$3*M11)*A10") 'VIDYA forecast
Call autofill("D11", "=100*(R11-S11)/ABS(R11+S11)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$11),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$11),1)" 'slope of line
Call autofill("L11", "=STDEV(A3:A11)") '9 MO STD DEV
Call autofill("M11", "=L11/$V$5") 'K value calculation
Call autofill("N11", "=ABS(A11-C11)") 'VIDYA MAD
Call autofill("O11", "= (N11)^2") 'VIDYA MSE
Call autofill("R11", "=SUM(P3:P11)") 'Su Mtm Up
Call autofill("S11", "=SUM(Q3:Q11)") 'Su Mtm Up
Call autofill("T11", "=ABS((R11-S11)/(R11+S11))") ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$11:$L$28)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 8 Then
Range("C11").Select
ActiveCell.formula = "=A11"
Call autofill("C12", "=(\$V\$3*M12)*A12+(1-\$V\$3*M12)*A11") 'VIDYA forecast
Call autofill("D12", "=100*(R12-S12)/ABS(R12+S12)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$12),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$12),1)" 'slope of line
Call autofill("L12", "=STDEV(A3:A12)") '10 MO STD DEV
Call autofill("M12", "=L12/\$V\$5") 'K value calculation
Call autofill("N12", "=ABS(A12-C12)") 'VIDYA MAD
Call autofill("O12", "=(N12)^2") 'VIDYA MSE
Call autofill("R12", "=SUM(P3:P12)") 'Su Mtm Up
Call autofill("S12", "=SUM(Q3:Q12)") 'Su Mtm Up
Call autofill("T12", "=ABS((R12-S12)/(R12+S12)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE(\$L\$12:\$L\$31)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 9 Then
Range("C12").Select
ActiveCell.formula = "=A12"
Call autofill("C13", "=(\$V\$3*M13)*A13+(1-\$V\$3*M13)*A12") 'VIDYA forecast
Call autofill("D13", "=100*(R13-S13)/ABS(R13+S13)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$13),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest(\$A\$3:\$A\$13),1)" 'slope of line
Call autofill("L13", "=STDEV(A3:A13)") '11 MO STD DEV
Call autofill("M13", "=L13/\$V\$5") 'K value calculation
Call autofill("N13", "=ABS(A13-C13)") 'VIDYA MAD
Call autofill("O13", "=(N13)^2") 'VIDYA MSE
Call autofill("R13", "=SUM(P3:P13)") 'Su Mtm Up
Call autofill("S13", "=SUM(Q3:Q13)") 'Su Mtm Up
Call autofill("T13", "=ABS((R13-S13)/(R13+S13)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE(\$L\$13:\$L\$34)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 10 Then
Range("C13").Select
ActiveCell.formula = "=A13"
Call autofill("C14", "=(\$V\$3*M14)*A14+(1-\$V\$3*M14)*A13") 'VIDYA forecast
Call autofill("D14", "=100*(R14-S14)/ABS(R14+S14)") 'CMO Indicator Equation

```

```

Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$14),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$14),1)" 'slope of line
Call autofill("L14", "=STDEV(A3:A14)") '12 MO STD DEV
Call autofill("M14", "=L14/$V$5") 'K value calculation
Call autofill("N14", "=ABS(A14-C14)") 'VIDYA MAD
Call autofill("O14", "=(N14)^2") 'VIDYA MSE
Call autofill("R14", "=SUM(P3:P14)") 'Su Mtm Up
Call autofill("S14", "=SUM(Q3:Q14)") 'Su Mtm Up
Call autofill("T14", "=ABS((R14-S14)/(R14+S14)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$14:$L$37)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 11 Then
Range("C14").Select
ActiveCell.formula = "=A14"
Call autofill("C15", "=( $V$3*M15)*A15+(1-$V$3*M15)*A14)" 'VIDYA forecast
Call autofill("D15", "=100*(R15-S15)/ABS(R15+S15)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$15),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$15),1)" 'slope of line
Call autofill("L15", "=STDEV(A3:A15)") '13 MO STD DEV
Call autofill("M15", "=L15/$V$5") 'K value calculation
Call autofill("N15", "=ABS(A15-C15)") 'VIDYA MAD
Call autofill("O15", "=(N15)^2") 'VIDYA MSE
Call autofill("R15", "=SUM(P3:P15)") 'Su Mtm Up
Call autofill("S15", "=SUM(Q3:Q15)") 'Su Mtm Up
Call autofill("T15", "=ABS((R15-S15)/(R15+S15)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$15:$L$40)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 12 Then
Range("C15").Select
ActiveCell.formula = "=A15"
Call autofill("C16", "=( $V$3*M16)*A16+(1-$V$3*M16)*A15)" 'VIDYA forecast
Call autofill("D16", "=100*(R16-S16)/ABS(R16+S16)") 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$16),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$16),1)" 'slope of line
Call autofill("L16", "=STDEV(A3:A16)") '14 MO STD DEV

```

```

Call autofill("M16", "=L16/$V$5") 'K value calculation
Call autofill("N16", "=ABS(A16-C16)") 'VIDYA MAD
Call autofill("O16", "=(N16)^2") 'VIDYA MSE
Call autofill("R16", "=SUM(P3:P16)") 'Su Mtm Up
Call autofill("S16", "=SUM(Q3:Q16)") 'Su Mtm Up
Call autofill("T16", "=ABS((R16-S16)/(R16+S16)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$16:$L$43)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 13 Then
Range("C16").Select
ActiveCell.formula = "=A16"
Call autofill("C17", "=( $V$3*M17)*A17+(1-$V$3*M17)*A16)" 'VIDYA forecast
Call autofill("D17", "=100*(R17-S17)/ABS(R17+S17))" 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$17),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$17),1)" 'slope of line
Call autofill("L17", "=STDEV(A3:A17)") '15 MO STD DEV
Call autofill("M17", "=L17/$V$5") 'K value calculation
Call autofill("N17", "=ABS(A17-C17)") 'VIDYA MAD
Call autofill("O17", "=(N17)^2") 'VIDYA MSE
Call autofill("R17", "=SUM(P3:P17)") 'Su Mtm Up
Call autofill("S17", "=SUM(Q3:Q17)") 'Su Mtm Up
Call autofill("T17", "=ABS((R17-S17)/(R17+S17)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$17:$L$46)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 14 Then
Range("C17").Select
ActiveCell.formula = "=A17"
Call autofill("C18", "=( $V$3*M18)*A18+(1-$V$3*M18)*A17)" 'VIDYA forecast
Call autofill("D18", "=100*(R18-S18)/ABS(R18+S18))" 'CMO Indicator Equation
Range("H2").Select
ActiveCell.formula = "=index(linest($A$3:$A$18),2)" 'Y intercept
Range("I2").Select
ActiveCell.formula = "=index(linest($A$3:$A$18),1)" 'slope of line
Call autofill("L18", "=STDEV(A3:A18)") '16 MO STD DEV
Call autofill("M18", "=L18/$V$5") 'K value calculation
Call autofill("N18", "=ABS(A18-C18)") 'VIDYA MAD
Call autofill("O18", "=(N18)^2") 'VIDYA MSE
Call autofill("R18", "=SUM(P3:P18)") 'Su Mtm Up
Call autofill("S18", "=SUM(Q3:Q18)") 'Su Mtm Up

```



```

Call autofill("T18", "=ABS((R18-S18)/(R18+S18)))" ' ABS CMO
Range("V5").Select
ActiveCell.formula = "=AVERAGE($L$18:$L$49)" 'VIDYA Constant of Ave Std
Dev

```

```

ElseIf Momentum = 15 Then
    Range("C18").Select
    ActiveCell.formula = "=A18"
    Call autofill("C19", "=( $V$3*M19)*A19+(1-$V$3*M19)*A18)" 'VIDYA forecast
    Call autofill("D19", "=100*(R19-S19)/ABS(R19+S19)") 'CMO Indicator Equation
    Range("H2").Select
    ActiveCell.formula = "=index(linest($A$3:$A$19),2)" 'Y intercept
    Range("I2").Select
    ActiveCell.formula = "=index(linest($A$3:$A$19),1)" 'slope of line
    Call autofill("L19", "=STDEV(A3:A19)") '17 MO STD DEV
    Call autofill("M19", "=L19/$V$5") 'K value calculation
    Call autofill("N19", "=ABS(A19-C19)") 'VIDYA MAD
    Call autofill("O19", "=(N19^2)" 'VIDYA MSE
    Call autofill("R19", "=SUM(P3:P19)") 'Su Mtm Up
    Call autofill("S19", "=SUM(Q3:Q19)") 'Su Mtm Up
    Call autofill("T19", "=ABS((R19-S19)/(R19+S19)))" ' ABS CMO
    Range("V5").Select
    ActiveCell.formula = "=AVERAGE($L$19:$L$52)" 'VIDYA Constant of Ave Std
Dev

```

```

Else
Momentum = 16
    Range("C19").Select
    ActiveCell.formula = "=A19"
    Call autofill("C20", "=( $V$3*M20)*A20+(1-$V$3*M20)*A19)" 'VIDYA forecast
    Call autofill("D20", "=100*(R20-S20)/ABS(R20+S20)") 'CMO Indicator Equation
    Range("H2").Select
    ActiveCell.formula = "=index(linest($A$3:$A$20),2)" 'Y intercept
    Range("I2").Select
    ActiveCell.formula = "=index(linest($A$3:$A$20),1)" 'slope of line
    Call autofill("L20", "=STDEV(A3:A20)") '18 MO STD DEV
    Call autofill("M20", "=L20/$V$5") 'K value calculation
    Call autofill("N20", "=ABS(A20-C20)") 'VIDYA MAD
    Call autofill("O20", "=(N20^2)" 'VIDYA MSE
    Call autofill("R20", "=SUM(P3:P20)") 'Su Mtm Up
    Call autofill("S20", "=SUM(Q3:Q20)") 'Su Mtm Up
    Call autofill("T20", "=ABS((R20-S20)/(R20+S20)))" ' ABS CMO
    Range("V5").Select
    ActiveCell.formula = "=AVERAGE($L$20:$L$55)" 'VIDYA Constant of Ave Std
Dev

```

```

    End If
    Range("A2:Y1000").Select
    With Selection
        .HorizontalAlignment = xlCenter
        .VerticalAlignment = xlBottom
        .WrapText = False
        .Orientation = xlHorizontal
    End With
    Selection.NumberFormat = "0.0000"
    Selection.EntireColumn.AutoFit
End Sub

' SOLVE_DES_MAD Macro
' Solves for the optimal alpha and beta values for DES MAD
'
'
Sub SOLVE_DES_MAD()

    Sheets("Evaluation Sheet").Select
    Range("v3").Select
    i = 1
    sheet = "Evaluation Sheet"
    minsse = Worksheets(sheet).Cells(2, 10)
    alpha = Worksheets(sheet).Cells(3, 22)
    beta = Worksheets(sheet).Cells(4, 22)
    While Worksheets(sheet).Cells(3, 22) >= 0.05
        While Worksheets(sheet).Cells(4, 22) >= 0.05
            If Worksheets(sheet).Cells(2, 10) < minsse Then
                minsse = Worksheets(sheet).Cells(2, 10)
                alpha = Worksheets(sheet).Cells(3, 22)
                beta = Worksheets(sheet).Cells(4, 22)
            End If
            ' Worksheets("Sheet3").Cells(i, 1) = Worksheets(sheet).Cells(3, 22)
            ' Worksheets("Sheet3").Cells(i, 2) = Worksheets(sheet).Cells(4, 22)
            ' Worksheets("Sheet3").Cells(i, 3) = Worksheets(sheet).Cells(2, 10)
            ' i = i + 1
            Worksheets(sheet).Cells(4, 22) = _
                Worksheets(sheet).Cells(4, 22) - 0.05
        Wend
        Worksheets(sheet).Cells(4, 22) = 0.5
        Worksheets(sheet).Cells(3, 22) = _
            Worksheets(sheet).Cells(3, 22) - 0.05
    Wend
    Worksheets(sheet).Cells(3, 22) = alpha
    Worksheets(sheet).Cells(4, 22) = beta

```

```

Sheets("Sheet2").Select
Sheets("Sheet2").Name = "Comparison Table"
Range("A2").Select
ActiveCell.Value = 1
Range("A3").Select
ActiveCell.Value = 2
Range("A4").Select
ActiveCell.Value = 3
Range("A5").Select
ActiveCell.Value = 4
Range("A6").Select
ActiveCell.Value = 5
Range("A7").Select
ActiveCell.Value = 6
Range("C1").Select
ActiveCell.formula = "Error"

```

```

Sheets("Evaluation Sheet").Select
Range("F2").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("C2").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
    SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"
Range("B2").Select
ActiveCell.formula = "Naive MAD"
Sheets("Evaluation Sheet").Select
Range("G2").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("C3").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
    SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"
Range("B3").Select
ActiveCell.formula = "Naive MSE"

```

```

Sheets("Evaluation Sheet").Select
Range("J2").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("C4").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _

```

```

        SkipBlanks:=False, Transpose:=False
        Selection.NumberFormat = "0.0000"
        Range("B4").Select
        ActiveCell.formula = "DES MAD"

        Sheets("Evaluation Sheet").Select
        Range("V3").Select
        Selection.Copy
        Sheets("Comparison Table").Select
        Range("D4").Select
        Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
            SkipBlanks:=False, Transpose:=False
        Selection.NumberFormat = "0.0000"
        Range("D1").Select
        ActiveCell.formula = "ALPHA"

        Sheets("Evaluation Sheet").Select
        Range("V4").Select
        Selection.Copy
        Sheets("Comparison Table").Select
        Range("E4").Select
        Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
            SkipBlanks:=False, Transpose:=False
        Selection.NumberFormat = "0.0000"
        Range("E1").Select
        ActiveCell.formula = "BETA"

        Sheets("Evaluation Sheet").Select
        Range("V3").Select
        ActiveCell.formula = "=.5" 'Start value for Alpha
        Range("V4").Select
        ActiveCell.formula = "=.5" 'Start value for Beta
    End Sub

' SOLVE_DES_MSE Macro
' Solves for the optimal alpha and beta values for DES MSE by minimizing the overall
MSE
'
'
Sub SOLVE_DES_MSE()
    Sheets("Evaluation Sheet").Select
    sheet = "Evaluation Sheet"
    minsse = Worksheets(sheet).Cells(2, 11)
    alpha = Worksheets(sheet).Cells(3, 22)
    beta = Worksheets(sheet).Cells(4, 22)

```

```

While Worksheets(sheet).Cells(3, 22) >= 0.05
  While Worksheets(sheet).Cells(4, 22) >= 0.05
    If Worksheets(sheet).Cells(2, 11) < minsse Then
      minsse = Worksheets(sheet).Cells(2, 11)
      alpha = Worksheets(sheet).Cells(3, 22)
      beta = Worksheets(sheet).Cells(4, 22)
    End If
    Worksheets(sheet).Cells(4, 22) = _
      Worksheets(sheet).Cells(4, 22) - 0.05
  Wend
  Worksheets(sheet).Cells(4, 22) = 0.5
  Worksheets(sheet).Cells(3, 22) = _
    Worksheets(sheet).Cells(3, 22) - 0.05
Wend
Worksheets(sheet).Cells(3, 22) = alpha
Worksheets(sheet).Cells(4, 22) = beta

Sheets("Evaluation Sheet").Select
Range("K2").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("C5").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
  SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"
Range("B5").Select
ActiveCell.formula = "DES MSE"

Sheets("Evaluation Sheet").Select
Range("V3").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("D5").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
  SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"

Sheets("Evaluation Sheet").Select
Range("V4").Select
Selection.Copy
Sheets("Comparison Table").Select
Range("E5").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
  SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"

```

```

    Sheets("Evaluation Sheet").Select
    Range("V3").Select
    ActiveCell.formula = "=.5" 'Start value for Alpha
    Range("V4").Select
    ActiveCell.formula = "=.5" 'Start value for Beta
End Sub

' SOLVE_VIDYA_MAD Macro
' Solves for the optimal alpha value for VIDYA MAD
'
Sub SOLVE_VIDYA_MAD()
    Sheets("Evaluation Sheet").Select
    sheet = "Evaluation Sheet"
    minsse = Worksheets(sheet).Cells(2, 14)
    alpha = Worksheets(sheet).Cells(3, 22)
    While Worksheets(sheet).Cells(3, 22) >= 0.05
        If Worksheets(sheet).Cells(2, 14) < minsse Then
            minsse = Worksheets(sheet).Cells(2, 14)
            alpha = Worksheets(sheet).Cells(3, 22)
        End If
        Worksheets(sheet).Cells(3, 22) = _
            Worksheets(sheet).Cells(3, 22) - 0.01
    Wend
    Worksheets(sheet).Cells(3, 22) = alpha

    Sheets("Evaluation Sheet").Select
    Range("N2").Select
    Selection.Copy
    Sheets("Comparison Table").Select
    Range("C6").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Selection.NumberFormat = "0.0000"
    Range("B6").Select
    ActiveCell.formula = "VIDYA MAD"

    Sheets("Evaluation Sheet").Select
    Range("V3").Select
    Selection.Copy
    Sheets("Comparison Table").Select
    Range("D6").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Selection.NumberFormat = "0.0000"

```

```

Range("E6").Select
ActiveCell.formula = "N/A"

Sheets("Evaluation Sheet").Select
Range("V3").Select
ActiveCell.formula = "=.5" 'Start value for Alpha
Range("V4").Select
ActiveCell.formula = "=.5" 'Start value for Beta

End Sub

' SOLVE_VIDYA_MSE Macro
' Solves for the optimal alpha and beta values for VIDYA MSE
'
Sub SOLVE_VIDYA_MSE()
    Sheets("Evaluation Sheet").Select
    Sheets("Evaluation Sheet").Select
    sheet = "Evaluation Sheet"
    minsse = Worksheets(sheet).Cells(2, 15)
    alpha = Worksheets(sheet).Cells(3, 22)
    While Worksheets(sheet).Cells(3, 22) >= 0.05
        If Worksheets(sheet).Cells(2, 15) < minsse Then
            minsse = Worksheets(sheet).Cells(2, 15)
            alpha = Worksheets(sheet).Cells(3, 22)
        End If
        Worksheets(sheet).Cells(3, 22) = _
            Worksheets(sheet).Cells(3, 22) - 0.01
    Wend
    Worksheets(sheet).Cells(3, 22) = alpha

    Sheets("Evaluation Sheet").Select
    Range("O2").Select
    Selection.Copy
    Sheets("Comparison Table").Select
    Range("C7").Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Selection.NumberFormat = "0.0000"
    Range("B7").Select
    ActiveCell.formula = "VIDYA MSE"

    Sheets("Evaluation Sheet").Select
    Range("V3").Select
    Selection.Copy
    Sheets("Comparison Table").Select

```

```

Range("D7").Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
    SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"
Range("E7").Select
ActiveCell.formula = "N/A"
Range("A1:E7").Select
Selection.EntireColumn.AutoFit

Sheets("Evaluation Sheet").Select
Range("V3").Select
ActiveCell.formula = "=".5" 'Start value for Alpha
Range("V4").Select
ActiveCell.formula = "=".5" 'Start value for Beta

End Sub

Sub Sort()
    Sheets("Comparison Table").Select
    Range("A1:E7").Select
    Selection.Sort _
        Key1:=Range("C2"), Order1:=xlAscending, _
        Key2:=Range("D2"), Order2:=xlAscending, _
        Key3:=Range("E2"), Order3:=xlAscending, _
        Header:=xlYes, OrderCustom:=1, MatchCase:=False, Orientation:= _
        xlTopToBottom
End Sub

Sub SelectTest()
    Sheets("Evaluation Sheet").Cells(3, 22).Value _
        = Sheets("Comparison Table").Cells(2, 4).Value
    Sheets("Evaluation Sheet").Cells(4, 22).Value _
        = Sheets("Comparison Table").Cells(2, 5).Value
    Sheets("Evaluation Sheet").Select 'selection for the price values
    i = 3
    Do Until Cells(i, 1).Value = ""
        i = i + 1
    Loop
    Range(Cells(i - Months, 1), Cells(i - 1, 1)).Select
    Selection.Copy
    Sheets("Sheet3").Select
    Cells(2, 2).Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Selection.NumberFormat = "$#,##0.00"

```



```

Range("B1").Select
ActiveCell.FormulaR1C1 = "Price"
Range("A1").Select
ActiveCell.FormulaR1C1 = "CMO"
Sheets("Evaluation Sheet").Select 'selection for CMO values
i = Momentum + 4
Do Until Cells(i, 4).Value = ""
    i = i + 1
Loop
Range(Cells(i - Months, 4), Cells(i - 1, 4)).Select
Selection.Copy
Sheets("Sheet3").Select
Cells(2, 1).Select
Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
    SkipBlanks:=False, Transpose:=False
Selection.NumberFormat = "0.0000"

Sheets("Comparison Table").Select
If Cells(2, 1).Value <= 2 Then
    Msg = "Naive Forecast has minimum error!"
    dialogstyle = vbOK + vbCritical
    Title = "Forecast Instability Error"
    response = MsgBox(Msg, dialogstyle, Title)
    If response = vbOK Then
        GoTo Endit
    End If
    MsgBox Msg
Endit:

ElseIf Cells(2, 1).Value <= 4 Then
    Sheets("Evaluation Sheet").Select 'selection for the DES values
    i = 3
    Do Until Cells(i, 2).Value = "" "" indicates find null space
        i = i + 1
    Loop
    Range(Cells(i - Months, 2), Cells(i - 1, 2)).Select
    Selection.Copy
    Sheets("Sheet3").Select
    Cells(2, 3).Select
    Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, _
        SkipBlanks:=False, Transpose:=False
    Selection.NumberFormat = "$#,##0.00"
    Range("C1").Select
    ActiveCell.FormulaR1C1 = "DES"

```

Else

Sheets("Evaluation Sheet").Select 'selection for VIDYA values

i = Momentum + 4

Do Until Cells(i, 3).Value = ""

i = i + 1

Loop

Range(Cells(i - Months, 3), Cells(i - 1, 3)).Select

Selection.Copy

Sheets("Sheet3").Select

Cells(2, 3).Select

Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone, \_

SkipBlanks:=False, Transpose:=False

Selection.NumberFormat = "\$#,##0.00"

Range("C1").Select

ActiveCell.FormulaR1C1 = "VIDYA"

End If

Sheets("Sheet3").Select

Range(Cells(1, 1), Cells(Months + 1, 3)).Select

Charts.Add

If Months = 3 Then

ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C4"), \_

Gallery:=xlCombination, Format:=2, PlotBy:= \_

xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, \_

Title:="", CategoryTitle="Months", ValueTitle="Momentum", \_

ExtraTitle="Price"

ElseIf Months = 6 Then

ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C7"), \_

Gallery:=xlCombination, Format:=2, PlotBy:= \_

xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, \_

Title:="", CategoryTitle="Months", ValueTitle="Momentum", \_

ExtraTitle="Price"

ElseIf Months = 9 Then

ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C10"), \_

Gallery:=xlCombination, Format:=2, PlotBy:= \_

xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, \_

Title:="", CategoryTitle="Months", ValueTitle="Momentum", \_

ExtraTitle="Price"

ElseIf Months = 12 Then

ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C13"), \_

Gallery:=xlCombination, Format:=2, PlotBy:= \_

```
xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, _  
Title:="", CategoryTitle:="Months", ValueTitle:="Momentum", _  
ExtraTitle:="Price"
```

ElseIf Months = 15 Then

```
ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C16"), _  
Gallery:=xlCombination, Format:=2, PlotBy:= _  
xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, _  
Title:="", CategoryTitle:="Months", ValueTitle:="Momentum", _  
ExtraTitle:="Price"
```

ElseIf Months = 18 Then

```
ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C19"), _  
Gallery:=xlCombination, Format:=2, PlotBy:= _  
xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, _  
Title:="", CategoryTitle:="Months", ValueTitle:="Momentum", _  
ExtraTitle:="Price"
```

ElseIf Months = 21 Then

```
ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C22"), _  
Gallery:=xlCombination, Format:=2, PlotBy:= _  
xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, _  
Title:="", CategoryTitle:="Months", ValueTitle:="Momentum", _  
ExtraTitle:="Price"
```

ElseIf Months = 24 Then

```
ActiveChart.ChartWizard Source:=Sheets("Sheet3").Range("A1:C25"), _  
Gallery:=xlCombination, Format:=2, PlotBy:= _  
xlColumns, CategoryLabels:=0, SeriesLabels:=1, HasLegend:=1, _  
Title:="", CategoryTitle:="Months", ValueTitle:="Momentum", _  
ExtraTitle:="Price"
```

End If

```
ActiveChart.SeriesCollection(2).Select  
ActiveChart.SeriesCollection(2).AxisGroup = 2  
ActiveChart.ChartGroups(2).Type = xlLine  
ActiveChart.Axes(xlValue).Select  
With ActiveChart.Axes(xlValue)  
    .MinimumScale = -100  
    .MaximumScale = 100  
    .MinorUnit = 5  
    .MajorUnit = 10  
    .Crosses = xlAutomatic  
    .ReversePlotOrder = False  
    .ScaleType = False
```

```

End With
ActiveChart.Axes(xlValue).Select
Selection.TickLabels.NumberFormat = "0"
With ActiveChart.Axes(xlValue, xlSecondary)
    .MinimumScale = 0
    .MajorUnit = 0.02
End With
ActiveChart.Axes(xlCategory).Select
ActiveChart.SeriesCollection(1).Select
With Selection.Border
    .Weight = xlThin
    .LineStyle = xlAutomatic
End With
Selection.InvertIfNegative = False
With Selection.Interior
    .ColorIndex = 24
    .Pattern = xlSolid
End With
ActiveChart.SeriesCollection(2).Select
With Selection.Border
    .ColorIndex = 5
    .Weight = xlThin
    .LineStyle = xlContinuous
End With
With Selection
    .MarkerBackgroundColorIndex = 5
    .MarkerForegroundColorIndex = 5
    .MarkerStyle = xlTriangle
    .Smooth = False
End With
ActiveChart.SeriesCollection(3).Select
With Selection.Border
    .ColorIndex = 5
    .Weight = xlThin
    .LineStyle = xlContinuous
End With
With Selection
    .MarkerBackgroundColorIndex = 5
    .MarkerForegroundColorIndex = 5
    .MarkerStyle = xlTriangle
    .Smooth = False
End With
ActiveChart.SeriesCollection(2).Select
With Selection.Border
    .ColorIndex = 7

```

```

        .Weight = xlThin
        .LineStyle = xlContinuous
    End With
    With Selection
        .MarkerBackgroundColorIndex = 7
        .MarkerForegroundColorIndex = 7
        .MarkerStyle = xlTriangle
        .Smooth = False
    End With
    ActiveChart.PlotArea.Select
    With Selection.Border
        .ColorIndex = 16
        .Weight = xlThin
        .LineStyle = xlContinuous
    End With
    Selection.Interior.ColorIndex = xlNone
    ActiveChart.Deselect
End Sub

```

```

Sub Selectspace()
    Sheets("Evaluation Sheet").Select
    Range("A1").Select
    Sheets("Comparison Table").Select
    Range("A1:A7").Select
    Selection.Delete Shift:=xlToLeft
    Range("A1:D7").Select
    Selection.EntireColumn.AutoFit
    Range("A1").Select
    Sheets("Sheet3").Select
    Range("A1").Select
    Sheets("Chart1").Select
End Sub

```

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
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13. ABSTRACT (Maximum 200 words)  This report documents a study of commodity bid offers made to the Defense National Stockpile Center (DNSC). The purpose of the study was to provide DNSC with better information about potential changes in market commodity prices. This report provides the project findings of the new PC based price forecasting model, "market basket" decision support package, and "optimal" price methodology.				
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